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'APR 14 1997

Federal Communications Commission
Office of Secretary

6th March 1997

Peter Wolfe Esq
Policy division
Wireless Telecommunications Bureau
Federal Committees Commission
Washington DC

Dear Sir

Location of E911 Calls using the Mobile Telephone Network

I have read the FCC document (July 26th 1996, No 94-102) describing the future requirements for E911 emergency calls. Of particular interest is the need to locate calls to within 125 metres for 67% of the time.

Cambridge Positioning Systems (CPS) has developed a location technology capable of finding position to within 75 metres using the GSM networks at 900 MHz. Some press clippings are attached describing the technique.

I would be grateful if you could bring the method to the notice of interested parties within the FCC, and other companies, since we intend to introduce it as a worldwide standard to be implemented on every digital handset. If you would like further information please contact me.

Yours sincerely,

Duncan Stewart

Duncan Stewart

Encl: Press clippings and CURSOR document

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These notes provide a general perspective of the GSM-CURSOR location system and the market opportunity. They do not claim to be accurate or constitute an offer to participate in any commercial or development activity.

DRAFT

POSITION LOCATION USING THE GSM DIGITAL TELEPHONE NETWORK (GSM-CURSOR)

1. Cambridge Positioning Systems Ltd (CPS), is an innovative company based in Cambridge with patented technology.
2. CPS is developing a commercial personal location system (GSM-CURSOR) based upon the conventional digital telephone handset (GSM). Performance tests are underway in Cambridge. It offers an initial potential market of £225 million with 200 million subscribers by 2000.
3. Tests with prototype equipment have demonstrated accuracies of 70 metres in urban areas in Cambridge and improvements to below 50 metres are expected.
4. GSM-CURSOR measures time differences between signals from GSM transmitters at the handset and at a fixed "base station".
5. The position of the handset is calculated when requested by the user by a central processor (CURSOR Position Processor, CPP) and the position sent back to the handset over the GSM link. Alternatively, if the user makes an emergency call (999, 911, etc) the position is calculated by the CPP and sent automatically to the emergency services. If the user so wishes, the location of the handset can also be determined remotely, e.g., by a manager to locate his sales representative.
6. The GSM CURSOR location system can also be used to interrogate local databases (SPDs) to obtain locality-specific information, e.g., nearest hospital, tourist attractions etc.
7. GSM CURSOR provides detailed map information showing the names of streets and giving directions to places of interest including tourist sites and postal code addresses. (see Figure 1)

8. The GSM CURSOR infrastructure, a local Service Provider Database (SPD) and CURSOR Position Processor (CPP), will be provided and maintained by CPS.

9. **Handsets**

All GSM mobile phone handsets will in future contain CURSOR functions which will be enabled for subscribers on an annual basis. No hardware changes are needed, only small modifications to the firmware. Future designs of handset will allow the position to be calculated internally and open up further market opportunities.

10. **Charging/Pricing Policy**

CPS will reach agreement with existing GSM suppliers in conjunction with network operators, service providers etc. CPS does not intend to compete with existing suppliers of mobile telephones and services.

11. **Commercial Agreements**

CPS intends to enter into commercial agreements to exploit GSM CURSOR throughout the world.

12. **Benefits/Risks of GSM CURSOR to CPS, the customers, and the suppliers**

(a) **Customers**

1. *Benefit to the public*

Emergency calls transmit location to the emergency services and are free.
Access to maps, directions and other database services which are position related.

Access to operator assistance when required in the local area.
Caller's position cannot be traced unless permission is given.

2. *Benefit to Corporate Customer*

Ability to locate individuals and goods.
Access to maps, directions and other database services which are position related.

Access to operator assistance when required in local area.

3. *Benefit to Emergency Services*

More efficient operation of 999 and 911 calls by locating position of caller
Location of emergency personnel increasing safety and response times.
No additional cost to the emergency service

(b) Suppliers

1. Benefit to network operator

Additional airtime revenue including premium rate services
Minor additional cost to operator in providing BTS position and frequency information for CPP.

2. Benefit to handset manufacturer

Premium charge on sale price
Minimal cost introduced by firmware changes

3. Benefit to service provider

Connection fee
Share of airtime revenue
Small additional cost to enable handset and subscriber agreement

4. Benefit to CPS

Margin on handset
Margin on airtime revenue
Revenue from use of database and operator assistance
Income from annual subscription
Advertising revenue from handset displays

The only significant risk is the provision of the infrastructure by CPS

13. Market

All GSM handsets are capable of becoming CURSOR enabled. The USA FCC Draft Regulations (1S136) calling for mobile telephones to provide a geographical position of 125 metres will be a driving force to market. The Home Office and UK police forces have expressed keen interest in this facility. There are currently approximately 30 million GSM 'phones worldwide and the number of subscribers forecast to reach 200 million in the year 2000.

A market survey (November 1996) by CPS has shown :

- (a) that 80% of women would prefer to buy a GSM 'phone with CURSOR functions because of the security features included for emergency calls;
- (b) 76% of those interviewed would use the telephone to obtain directions to a destination;
- (c) 63% would be willing to pay for the service.

The survey has formed the basis of the CPS pricing strategy.

The major European GSM phone subscribers are;

Major countries	Number of GSM subscribers at 31/7/96*	% of population
Finland	655,000	12.9
France	1,556,200	2.7
Germany	4,306,300	5.3
Italy	1,213,333	2.1
Netherlands	510,000	3.3
Spain	498,400	1.3
Sweden	1,353,100	15.4
United Kingdom	2,374,400	4.1

* Includes GSM 900 and DCS 180 0 (D1 GSM and D2 GSM Germany and F2 and Itineris GSM France)

Source: Mobile Communications International No 3 Nov 1996

14. Competition

The other location systems, i.e., GPS, Low Earth Orbiting Satellite (LEOs) and alternative GSM location methods, all suffer from a combination of low accuracy performance in urban areas or additional cost when compared for use in locating hand held mobile 'phones (see table attached).

15. Revenue Forecast

Country	1998	1999	2000	2001	2002
UK					
Europe					
RoW					
Totals					

16. Technical

To be transmitted only after completion of NDA

17. Future Developments

17.1 Vehicle pricing for city centres to relieve congestion and pollution

17.2 Location of stolen vehicles and tracking of high value loads.

Further information please call;

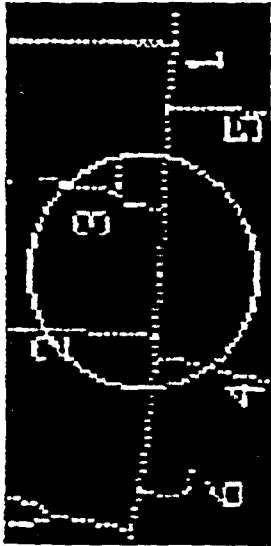
Duncan Stewart.

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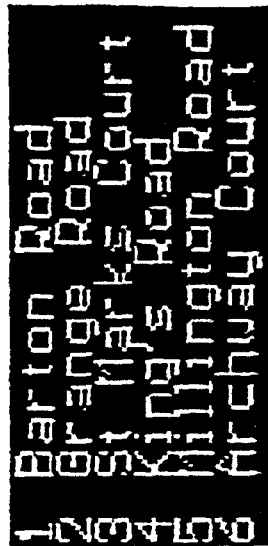
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COMPETITIVE TECHNOLOGIES TO GSM-CURSOR

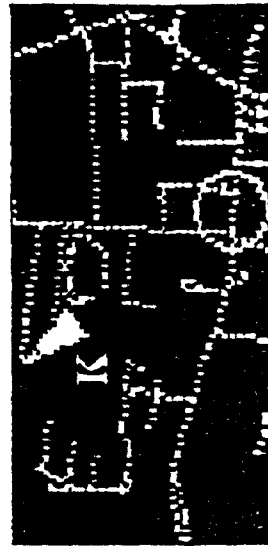
Type	Advantages	Disadvantages
GPS	Established Technology Widely available Moderate accuracy	1 Communications link required to base 2 High power consumption 3 Time delay to first fix in new locations 4 Poor performance in urban canyons 5 DGPS services to provide higher accuracy available at a price
Low Earth Orbit Satellite (Iridium etc)	Will be operational worldwide	1 Poor accuracy 2 Not yet available 3 Untested technology
Other GSM Systems		
(a) Synchronised Beacons	Benefit to network operator owning BTS	1 Poor accuracy 2 Cost penalty for synchronisation 3 Firmware changes needed to handset
(b) Signal strength method	Already demonstrated	1 Poor accuracy 2 Disbanded by major manufacturer
(c) Cell identification	Already in operation for emergency services	Very poor accuracy (unless BTS's are close together)
(d) Spatial Division Multiple Access (SDMA) antennas (Direction of receiver signal)	Few if any	Need to install dedicated direction finding antennas in all BTS's. Very costly. Accuracy poor.
(e) Phase measurement (using supplementary MW frequency)	Good penetration in urban environments High accuracy	Expense of additional frequency infrastructure
(f) Observed Time Difference	Few changes needed to infrastructure/handset	Major measurement errors caused by detection error and line-of-sight error
Wireless Systems	The majority of radio based systems are for local areas and do not compete with GSM-Cursor	
DataTrak/Loran/Omega	Already operational	1 Poor accuracy 2 Communications link required to base
GSM-CURSOR	Higher accuracy than other comparable GSM systems Preliminary tests completed demonstrating 70 metres accuracy. Minor changes needed to handset. No additional comms link required for transmitting position. Low power consumption.	Product development required Provision of infrastructure



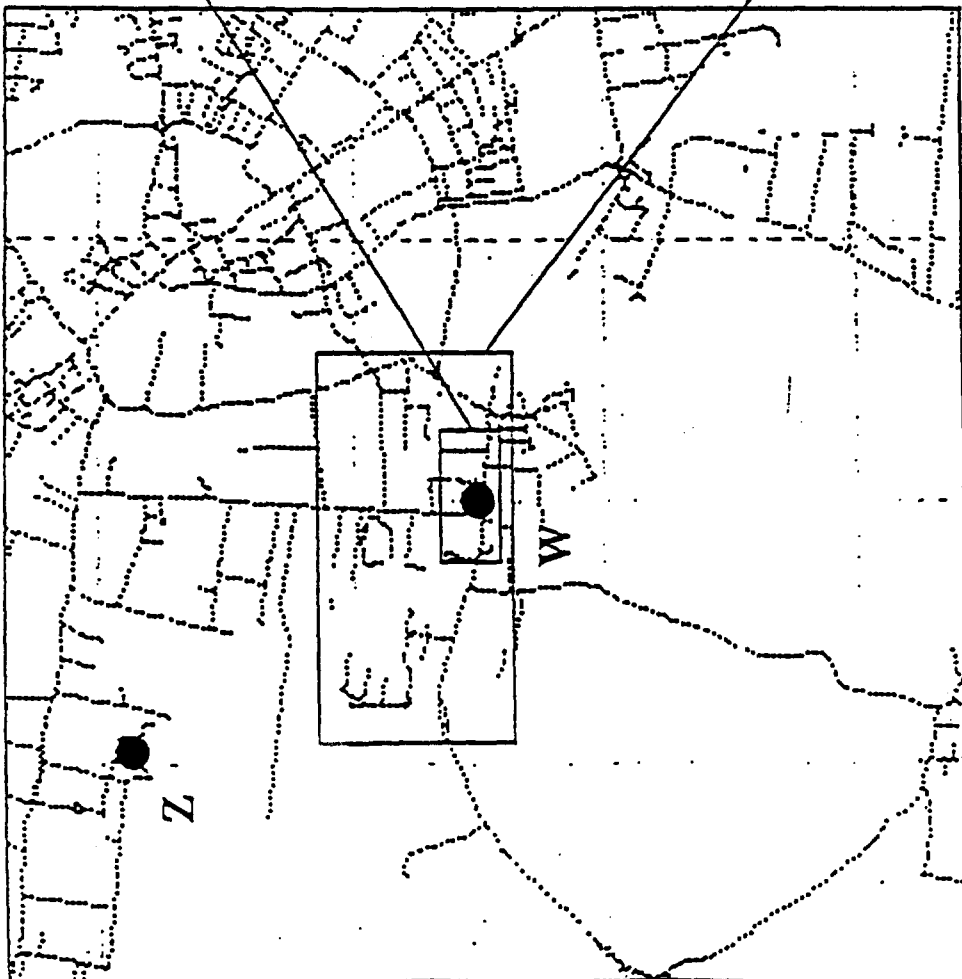
(a)



(b)



(c)



Phone Newsdesk: (01223) 43 44 55

Mobile phones help fight crime

■ **CAMBRIDGE:** Ingenious research in a Cambridge laboratory could turn the mobile phone into a major weapon against crime — as well as making it much harder for people to get lost.

Research which started life as a way of exploring distant galaxies, is now being hailed as a breakthrough which could become an important moneyspinner for Cambridge University.

Negotiations are already in progress with a number of major companies who are interested in taking up the technology, known as GSM Cursor, which lets mobile phones "know" where they are to within 50 metres (55 yards).

A user could simply dial a number to be given easy directions to the nearest restaurant or summon the emergency services — even when on unfamiliar ground.

A modified version could be fitted inside cars or expensive belongings to enable them to be tracked if they were stolen.

Dr Peter Duffett-Smith, Cursor's

inventor, said: "The technology is very straightforward — it's going to have a huge impact."

Cambridge crime prevention officer Pc Rob Mills said: "It sounds excellent and the potential is enormous."

Alan McInnes, staff officer to Tony Lake, chairman of the Association of Chief Police Officers' tracking group, said such devices were "like an informant ringing up and telling you you'll find the property at around a certain location."

However, he said this would be restricted by the expense of police manhours following up such leads.

William Ostrom, head of corporate affairs with Cellnet, said: "This is part of the information revolution — with applications like that, you're really starting to change people's lives."

Peter Sanders, Cursor project manager with Harston-based technology consultants Scientific Generics, said: "Cursor's potential is significantly greater than such modern success stories as Ionica — these are exciting times."

Cursor will use the existing relay



stations along with a new network of small base stations across the country and a simple reprogramming of the mobile phones themselves.

Cambridge Positioning Systems has been set up by the university to exploit GSM Cursor, with the help of Scientific Generics.

■ Solving a modern dilemma — See Page 8.

Getting in touch . . . the GSM Cursor technology, invented by Cambridge scientist Dr Peter Duffett-Smith, is set to have a huge impact.

GSM phones get GPS alternative

scientist designs system which can find GSM handsets without using GPS; Ericsson spokesman gives it thumbs up

Josilfovskaja

BRIDGE University has designed a system which allows a GSM handset's position to be calculated without requiring the Global Positioning System (GPS).

Professor Duffett-Smith, by his radio-astronomy, has designed a system which calculates a handset's position to an accuracy of 50m. The technology is based on interferometry and the positioning of the handset is determined

through a multiplicity of readings taken from various points.

The ability to locate handsets will enable numerous additional GSM services to be added. For example, it would enable emergency services to locate broken down cars or accidents, allow personal navigation, and even the locating of a stolen phone or car.

Duffett-Smith believes the technology, dubbed Cursor, could be adopted as early as this year and is currently in discussion with major handset and basestation manufacturers.

"There is a need for a

system like that [location/navigation] and there is definitely a market for it," said one Ericsson spokesman.

The main approach to combine location/navigation technology with GSM is GPS. "GPS is the Rolls-Royce of technology," said Richard Fry from the Technology Partnership. "The GPS infrastructure is already there. The problem with Cursor is people need to put the infrastructure in and it has to be low cost."

But GPS has four disadvantages when compared with Cursor: it is expensive to fit

into handsets, with a current accuracy of 100m it is not accurate enough for urban environments, it is power-hungry and it takes a while to position itself as it consults geostationary satellites.

With Cursor, the only modification needed in the handset is a software one.

Cambridge Positioning Systems, with Duffett-Smith as its technical director, has been set up to exploit the technology's commercial potential. In addition to Cursor, several other similar technologies are currently under development.

Cellular positioning

I enjoyed your very interesting article in the November/December 1996 issue of *ITS World* ("Wireless Technologies: DSRC, Cellular, and GPS," p. 21) and the limitations you highlighted of the technologies: GPS needs external communications, DSRC needs roadside readers, and cellular telephone systems need external positioning technology.

The Federal Communications Commission regulations that require mobile "phone position location to within 125 meters for 63 percent of the time for 911 calls" is now obtainable with the GSM cellular network. We have undertaken tests in Cambridge, United Kingdom, using simple GSM 900-MHz handsets and obtained accuracies of 70 meters in an urban environment within the specified time. We evaluated another demonstration system in December to provide better accuracy, theoretically less than 10 meters. Although all our work has so far concentrated on 900 MHz, we believe it will work as well on 1800 and 1900 MHz. In addition, our system will provide the location of a handset at a base station, at the handset, or both. It will therefore have wider applications in ITS than 911 emergencies.

Duncan Stewart
Cambridge Positioning Systems
Cambridge, United Kingdom

TECHNOLOGY

Let your fingers cut the walking

Alan Cane on a system which can provide mobile phone users with positioning information

Cambridge University scientists have developed a way of using mobile phones to determine a caller's geographical position. The technology, accurate to 50 metres, could prove cheaper than existing satellite-based systems and offers mobile phone manufacturers and network operators a new avenue for adding value to their services.

A small company, Cambridge Positioning Systems, has been set up to exploit the technology. It is talking to handset manufacturers and mobile network operators in the UK and abroad with a view to marketing the system.

Called Cursor, the technology was discovered by the Cambridge radio-astronomer Peter Duffett-Smith in the course of his research on distant galaxies. It has been developed by the university in conjunction with Scientific Generics, a local consultancy. Generics. Duffett-Smith is now technical director of CPS in addition to his duties as a university lecturer.

The principle of the system is simple. The UK is covered with a network of several thousand mobile phone base stations operating on the European digital standard GSM (Global System for Mobile Telephony). GSM base stations continually transmit conversations in the form of radio signals. These signals are received by GSM handsets which convert them back into speech.

Duffett-Smith's scheme envisages a second countrywide network of a few hundred Cursor stations able to receive but not send GSM transmissions.

The system is able to recognise when the same part of a radio signal arrives at a Cursor station and at a mobile phone. The time difference

position, using radio signals and time data from up to a dozen different GSM base stations.

The advantage of the Cursor system is that little has to be modified in the handset apart from some software. The Cursor stations are small and, as they have no transmission capabilities, comparatively cheap.

This compares with conventional satellite-based global positioning systems which cost about £150 in their simplest form.

Satellite systems, already widely used by land, sea and air craft, depend on timed signals from satellites in a geostationary orbit above the earth's surface. Experts warn, however, that the cheaper versions are only accurate to 100m or so. Greater accuracy requires more equipment.

Duffett-Smith sees a big market among mobile phone

users who would be prepared to pay a premium to be able to dial up particular kinds of information.

"The average person does not want to know where he or she is. He wants to know where his hotel is, or how far he is from the nearest pizzeria," he points out. The emergency services could also be big customers.

Peter Sanders, product manager for Cursor technology with Scientific Generics, believes the technology will come into its own with the next generation of mobile phones with screens large enough to display maps on which the position of the user could be pinpointed.

CPS has a working model of the system but no contracts. Cursor will work with any kind of radio signal - GSM, the PCS spectrum used by Orange and One-2-One and even commercial broadcasts.



The mobile phone that puts you in your place

MOBILE phone users may never be lost or hungry again thanks to a British invention which can pinpoint their exact location.

All they will have to do is dial a central computer which will then display a simple map on their phone showing where they are ... and could direct them to the nearest fast food outlet or petrol station. Police have welcomed

the device, which will enable them to trace stolen cars fitted with it to within 50 metres.

Cambridge University physicist Dr Peter Duffett-Smith developed the GSM Cursor system while working at the Mullard Radio Astronomy Observatory.

He discovered that a mobile phone can be located using simple mathematics and the

position of relay masts.

Cursor can be programmed into digital mobile phones and Dr Duffett-Smith claimed that using it would be simple and cost as little as 10p a call.

'Digital phones will gradually replace analogue ones and eventually we expect Cursor to be in everyone's mobile,' he said. 'The fact that Cursor has determined your position in

longitude and latitude won't be obvious, it will just tell you where you are or how to get to where you want to go.'

Dr Duffett-Smith said: 'Charges will depend upon the level of service. Directions to the nearest pizza place would probably cost about 10p. For an AA or RAC member who was lost and had broken down the charge to locate them might be 50p.' Technology

consultants Scientific Gen of Harston, Cambridgeshire already produced a prototype and potential investors are sought to develop the device commercially.

A Cambridge University spokesman said: 'We have hope there are companies and individuals out there who can bring some of their know-how to bear to get it to the market.'

U.K. astronomer devises navigation scheme as low-cost alternative to GPS

Cell phone positioned for new services

By Peter Clarke

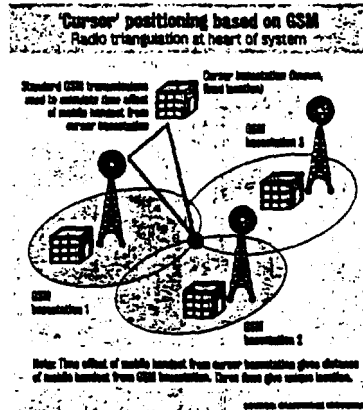
CAMBRIDGE, ENGLAND — A Cambridge University radio astronomer has designed a system that allows a digital cellular telephone's position to be determined to within about 160 feet. The system promises to enable a variety of services to be offered to cell-phone users at low cost, since it does not use expensive global positioning by satellite (GPS) techniques, nor does it require hardware changes within handsets or existing base stations.

The inventor, Peter Duffett-Smith, calls the system "Cursor." With help from the university's investment arm, Cambridge Research and Innovation Ltd. (CRIL), he has formed a company called Cambridge Positioning Systems Ltd. (CPS), with himself as technical director, to hold the patents, liaise with service providers and handset makers,

and to further develop the system.

So far, Cursor has been demonstrated with the Global System for Mobile communications (GSM) network in the Cambridge area, but is applicable to all cellular telephone systems, Duffett-Smith stressed, including PCS-1900 and other personal communication systems in the United States.

The technology is based on radio triangulation. A prime advantage of the Cursor system is that it uses the same frequencies and signals as the normal digital transmission—in the case of GSM, at 900 MHz. The triangulation techniques are the same ones Duffett-Smith has used as a radio astronomer to locate distant galaxies with multiple radio telescopes.



In the case of GSM handset positioning, Cursor uses a secondary network of base stations in fixed locations, which are effectively dummy handsets. Without adding anything to existing

base stations or altering the GSM signaling, it is possible to capture a portion of the total transmitted signal received at the mobile handset. This is retransmitted to the Cursor base station, where it is correlated with the signal as originally received at the Cursor base station.

The correlation determines the time difference between when the signals were received at the Cursor base station and the mobile handset, which in turn gives the distance of the mobile handset from the originating GSM base station. Performing this operation three times for different GSM base stations fixes the position of the mobile. In fact, Cursor uses 12 fixes to improve accuracy and reduce the number of Cursor base stations required.

"The average user doesn't want to know where he or she is—they probably already know—but what they may want is a positioning-related service," Duffett-Smith said. He envisions the user dialing into a special service provider and asking for a map of the local area, directions to the nearest bank or a list of restaurants. The service provider pinpoints the user's cell phone and then looks up the required information before sending it over the GSM short-messaging service. The information could appear as text instructions or as a bit-mapped display on the handset's LCD.

Such services could be the stimulus for adoption of a new generation of smart phones, in-car navigation systems and personal digital assistants. One idea is to embed the technology within expensive items, such as vehicles, to prevent theft.

Software modification

"Only numskulls would want to try and integrate GPS in a GSM handset. It would cost at least \$100 to add the hardware and be a large battery drain," said Duffett-Smith. Also, GPS offers poor accuracy and reliability in urban situations.

In contrast, GSM Cursor only requires a modification to the software in the handset. Because

of the low cost of entry, Duffett-Smith predicted that every handset manufacturer would provide GSM Cursor functions, although it will take time for Cursor base stations and services to be rolled out. He added: "The use of GSM Cursor in cars is very attractive. Makers can provide a telephone with the car, which is also a location system and in-car navigation system at no extra cost."

In-car navigation systems are currently based on GPS, "but they are a long way from the pocket of the volume car buyer," commented Duffett-Smith.

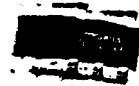
Medical navigation

Early trials of Cursor used a base station set up in Downing College where Duffett-Smith is a fellow. A modified handset could be located anywhere in about a 10- to 15-mile radius. Since then, a prototype system has been developed with engineering consultancy Scientific Generics Ltd., also based in Cambridge.

Some of the patents CPS holds date back to 1988. Originally, Duffett-Smith tried to find interest in a highly accurate system of positioning based on signal phase measurement and AM radio broadcasts. He demonstrated a vehicle navigated by pop-music reception. "It was only 18 months ago that we realized the GSM network was a golden opportunity for a lower-precision time-measurement system. We see a market opportunity. We hope to offer a product by the end of the year."

The next step is to raise capital and determine the detailed business plan. Duffett-Smith is not sure whether CPS should roll out a service on its own, in partnership with others or merely act as a licensor of the intellectual property. "Of course, we have been talking to Vodafone, Cellnet, Orange and Mercury 1-2-1 [the for mobile-phone-service operator in the United Kingdom]. But I want to roll this out with GSM quickly as possible," he said. "We are also talking to the handset manufacturers. They're being very forward-thinking, are the airtime providers. They know that their core business service, is topping off. They want to find ways of adding extra services."

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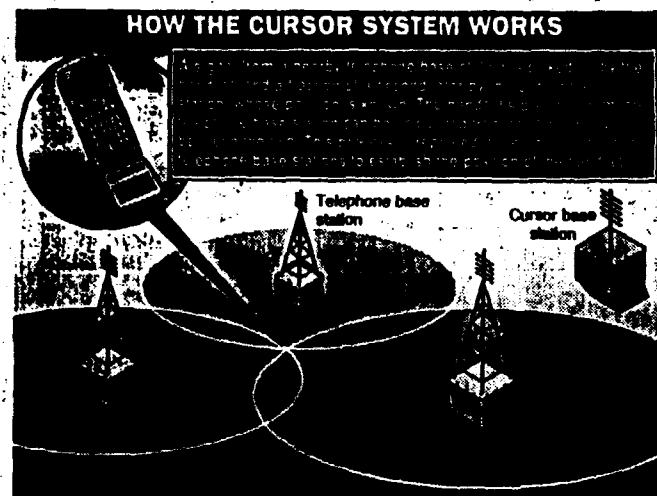
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When your mobile phone could tell you where to go . . .



LOST? Or looking for a bank? Your mobile telephone could soon be telling you where you are, thanks to a clever trick devised by a radio astronomer.

The Cursor system, invented by Peter Duffett-Smith of Cambridge University, lets your phone figure out your location to within 50 metres. As well as being more precise than satellite-based navigation systems, it is also considerably cheaper, because it requires only a small modification to digital mobile phone software.

The system uses radio triangulation to calculate the position of the handset by tak-

ing advantage of the signals that are constantly being sent between the cellphone and nearby antennae. The phone cannot work out its position on its own; it needs help from a nearby Cursor base station.

Each signal from a telephone base station is picked up by the handset, and a fraction of a second earlier or later by the Cursor base station. The handset's distance from the telephone base station can then be calculated from the time interval between the two.

By doing this three times, the position of the handset can be determined by triangulation. But figuring out the

whereabouts of the phone is only the beginning.

"The average user doesn't want to know where he or she is — they probably already know," says Duffett-Smith. What they may want, however, is a map of the area, directions to their hotel, or information about the nearest Chinese restaurant.

The cost of building a national network of 1,200 Cursor stations would be around £1 million, says Geoff Morris, chief executive of Cambridge Positioning Systems, the company set up to exploit the Cursor technology. That could be recouped by charging users a premium for the information

they retrieve. Cambridge Positioning Systems is showing its demonstration system to network operators, cellphone manufacturers, and service providers. The same network could be used by all four digital cellphone operators in Britain.

The system also provides a serious alternative to Global Positioning Satellite navigation systems. GPS uses a network of satellites built by the American military.

The disadvantage of Cursor is that it is not a global system, and can be introduced only in areas that already have cellphone coverage.

Chris George

Tuesday, February 4, 1997

The Daily Telegraph 3